CONFIDENTIAL – DELIBERATIVE PROCESS

Talking Points for Mamm Creek discussion with COGCC and CDPHE

January 13, 2014

Opening

- We have finished our review of the updated information COGCC and Garfield County provided us during the summer and fall of 2013 which included bradenhead data.
- We are glad we have found time together to speak with you about our observations associated with this review.
- Although we want to discuss with you our initial observations, we don't expect that we have all the information and our initial observations may change based on future conversations with you. We have lots of questions, think you have information we don't have and hope that this initial conversation prompts further discussion and collaboration on these topics.

Chronology

- Region 8's involvement was initially requested by a resident of the area in 2008, and has been coordinated with the COGCC since the outset. In our review of groundwater concerns, we've had the benefit of being able to consider work done by consultants for Garfield County and the COGCC.

  - EPA received a letter from a concerned citizen in July 2008 and multiple communication since then
  - We contacted COGCC in the fall of 2008 to discuss and share information
  - Through 2009 we had a series of conversations with COGCC and visited the area with your staff and other stakeholders (county, citizens)
  - In 2010 we did some initial analysis of well construction data and shared that with COGCC, and COGCC requested that we look at well construction data for additional wells (in the Miller area)
  - Met with COGCC in 2012 subsequent to COGCC follow up actions associated with Crescent Study commissioned by COGCC (although we did not formally comment on the Memorandum)
  - Region 8 had not heard further concerns from the resident until February 2013, when they requested that we look at significant new data and information that had been developed which we had not previously reviewed (ie bradenhead reports and water chemistry from water wells) During 2013 and early 2014 we notified the COGCC of the resident's request, obtained updated information from COGCC and other sources, and reviewed and analyzed the additional information.
  - Completed review of 2013 data made available by COGCC and Garfield County
  - ORD and OW review of R8 observations completed fall/winter 2014

What we found in our review

Region 8's review identified potential issues and observations related to gas well construction, water quality and air emissions in the area. Our observations from this review are not inconsistent with some of the previous studies (for example the well construction issues were identified in the Cresent Report), although the studies are not all consistent (as they relate to groundwater quality changes and their potential attribution to oil and gas production). It appears that the previous studies did not look comprehensively at all of the available information across the entire area. EPA attempted to synthesize all information we had available related to water quality, hydrogeology and well construction. Our hope is to get into the detail at a later date, but our primary observations are:

Technical Information on Well Construction

- Please see your first handout(s).
- The state has issued a NTO regarding well construction to require implementation of specific casing and cementing in the field. Many gas wells in the field are constructed with open annulus through the Wasatch drinking water aquifer system (USDW), and some have uncemented production casing annulus (or the open space between the casing and well bore wall) continuing down through the top of the upper most perforated section of the production formation (the Williams Fork formation). This construction does not appear to isolate the drinking water resource, as it provides opportunity for gas and liquids to move up this open annulus into the shallower portion of the Wasatch currently used for drinking water. Some gas wells are actually flowing liquid out of the annulus at the surface, which indicates higher pressures in the subsurface are pushing these liquids up the wellbore from deeper zones.

- EPA evaluated 348 Mamm Creek Gas wells. The 348 wells are not necessarily representative of the entire field. Of the 348 Mamm Creek gas wells evaluated, 91% had uncemented annulus in the lower part of the drinking water aquifer (Wasatch USDW); 25% also had uncemented annulus through the top of the production formation (Williams Fork formation.)

- Additional casing and cementing requirements on new wells have been implemented (enacted through notice to operators (NTOs) and conditions of approval (COAs). Bradenhead pressures are still observed in some recently drilled wells.

- The Crescent Report commissioned by COGCC identified that developers have experienced problems during drilling gas wells (e.g. loss of cement being circulated into the wellbore) and the area has complex geology with numerous natural faults and fractures. Wells constructed in this complex geology may provide additional pathways for movement of contaminants into USDW.

- Of the roughly 3500 gas wells EPA counted in the NTO Mamm Creek field area for which COGCC has required monitoring of pressure in the bradenhead annulus (between the production casing and the wellbore), nearly one-third (1061) have pressure on the annulus which indicates upward movement of gas in the well.

- Most of these 1061 wells are venting gas (including methane and VOCs of unknown concentration) to the atmosphere in an area where there are rural residences. Venting is relieving pressure in the well to reduce potential for gas migration into shallower zones. Venting of gas seems to be the remediation strategy generally implemented. Where remedial cementing has been performed to isolate the shallower zones, it has proved effective at eliminating bradenhead pressures.

- The 2013 bradenhead data indicates that 35 gas wells have liquid flowing out of the bradenhead annulus at the surface. An additional 40 Bill Barrett wells are connected to a tank suggesting potential liquid flow. This is an indication that fluid is moving up the wellbore from deeper zones with higher pressure and that these wells may not be constructed so as to eliminate the possibility of inter-zonal movement.

Technical information on groundwater quality review:

- See next handouts.

- Groundwater quality as reflected in existing water wells across the field shows declining quality trends coincident with the intensification of gas production in the area. Chloride, often a component of produced/deeper formation water, has increased an order of magnitude at a number of wells since production has ramped up, and thermogenically derived methane has increased more than an order of magnitude.

- The highest concentration of chloride detected in 76 private wells sampled prior to 2000 was 350 parts per million (ppm). The highest concentration detected in 492 private wells sampled after 2000, during and after the period of intensive development, was an order of magnitude greater- 3500 ppm. Although the sampling locations pre and post-2000 are not all identical (because additional wells were sampled during the later period), this gives an indication that chloride has increased significantly following development. Region 8 observes that chloride levels are trending up in 71 specific well locations that were sampled before and after 2000. (We recognize this may be an area where we could pull together all information and further evaluate water quality in the area and report the results to the public.)

- Similar trends occur with methane. The highest concentration in 9 private wells sampled prior to 2000 was <1 ppm. The highest concentration in 59 private wells sampled after 2000 was 27 ppm, greater than an order of magnitude increase. We observe that methane levels are also trending up in 9 specific well locations that were sampled before and after 2000.

- Some relevant studies hypothesize that the changes in water quality are as a result of natural migration. If this were the case, we might see equilibrium conditions and not expect to observe such significant trends within a short period of time. We might also expect that the higher pre-development concentrations would cluster near geologic faults, which is not the case. (We also recognize that we don't have enough wells near the hogback)

- A final observation is that groundwater monitoring is primarily limited to private wells. In some areas where we have concerns with gas well construction, where multiple gas wells are flowing liquid at the surface, only a few water wells have been sampled. As a result, there is little information regarding groundwater quality in those areas.

Ultimate Goals:

- Further explore and understand Mamm Creek data with state COGCC and CDPHE together and comprehensively
- Reach consensus on data and potential issues and solutions
- Get back to concerned resident with a coordinated response